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Use of Microcomputers at North County Transit District

June 1984

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In Cooperation With

American Public Transit Association

UMTA Technical Assistance Program

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Technical Assistance Report
June 1984

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NOTE: This report presents the conclusions of a contractor about how to meet the information management needs of one particular transit property through the use of microcomputer hardware. Part of its content includes recommendations for hardware choices and system configuration based on this contractor's analysis of the transit property's needs. Recognizing that there may be alternative approaches to meeting these needs, the recommendations should not be construed as any endorsement of the approach proposed by the U.S. Government. The U.S. Government does not endorse manufacturers or products, and trade names appear in the document only because they are essential to the content of the report.

FOREWORD

Many transit operators have begun to investigate the use of microcomputers to improve the collection, analysis, and distribution of management information. In particular, small transit systems have been attracted by the relatively low cost of microprocessors and the increasing ease in introducing their use into their organizations. APTA and UMTA have been actively seeking to assist these small transit systems in their efforts, primarily by serving as information sources on microcomputer use in the industry.

In addition, the APTA/UMTA Transit Productivity Program has been estabished to provide short-term technical assistance to transit operators who request assistance on a particular issue which involves system productivity. The results of the North County Transit District (NCTD) technical assistance effort are documented in this report. We believe the review of NCTD's needs and the recommended approach will be of interest to all bus systems.

Additional copies of this report are available from the National Technical Information Service (NTIS), Springfield, Virginia 22161.

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I. INTRODUCTION

This trip report documents technical assistance provided for North County Transit District (NCTD) in Oceanside, California under the UMTA/APTA Productivity Initiatives Program. NCTD has an in-house Texas Instruments 990/12 minicomputer which it uses for financial, payroll, vehicle maintenance, and scheduling functions. All systems are in production use, but there are both changes and enhancements to these functions which NCTD staff would like to see added in each of these areas, and there are other candidate areas in which NCTD would like to use a computer. Staff members were asked to list and describe candidate application areas for implementation on a computer. An independent consultant, asked to consider how NCTD should proceed to implement additional computer applications, recommended that microcomputers be considered for additional areas. The purpose of this technical assistance and report is to discuss each of these application areas, to recommend how each might be implemented, and to outline the configuration of computer hardware and software which would best serve NCTD's requirements.

II. EXISTING COMPUTER APPLICATIONS AT NCTD

NCTD has implemented the applications listed in Table 1 on its Texas Instrements 990/12 minicomputer and a standalone CPT word processor. All systems are in production use, but there are still problems with some of the programs. For some applications, not all features are implemented as designed or fully used. For some applications, enhancements or changes have been requested. NCTD has a full time programmer/operator on staff and a full time consultant working on both the changes to the system and regular production use of the system. Some of the problems are attributable to a lack of computer memory and disk storage space on the original system, but this problem has now been solved with an upgrade of both. Programs are now being modified to take full advantage of the new environment.

TABLE 1

EXISTING COMPUTER APPLICATIONS AT NCTD

Application	Developer	Status	Language
Payroll Timecard Input Gross-to-Net Personnel Records	Computer Applied Systems (CAS)	In production use (minor modifications currently being implemented)	COBOL
Financial General Ledger Accounts Payable Purchasing Fixed Asset Accounting	CAS	In production use (minor modifications currently being	COBOL
Operator Timeroll	Sage Management Consultants	In production use	COBOL
Vehicle Maintenance	Sage	In production (limited capability)	COBOL
Vehicle Scheduling (BUS SKED)	ATE Management and Service Co.	In production use (limited use)	FORTRAN
Word Processing	CPT	In production use	N/A

Most of the system was developed in a major system development project by Computer Applied Systems (CAS) and Sage Management Consultants. The initial system included the financial, payroll, operator timekeeping, and vehicle maintenance applications. The financial applications included general ledger (including Section 15 reporting), accounts payable, purchasing, and fixed assets modules. All of these applications were implemented in the COBOL programming language. NCTD has the source code of the programs themselves and so has rights and the ability to make any modifications or enhancements it so chooses. The vehicle scheduling package is used only to a limited extent and is not actually used to generate production schedules at this time.

III. POTENTIAL COMPUTER APPLICATIONS AT NCTD

Potential computer applications were identified in five general areas: financial, personnel, maintenance, operations, and planning and marketing. Application areas were discussed with key staff members in each of these areas. This report describes each application area, as identified by NCTD staff, and discusses how each might be implemented at NCTD, either on microcomputers or as an enhancement to the existing minicomputer system.

The application areas discussed are listed in Table 2, together with a summary implementation recommendation and a tentative priority rating. The priority ratings are based on preliminary discussions and are not intended to be a definitive priority list. Rather, they are intended to provide a basis for discussion within NCTD to determine the priority sequence in which applications and consequent hardware and software should merit attention and implementation effort.

Financial Application Areas

Three application areas were discussed for potential implementation at NCTD in the financial area: grant accounting

TABLE 2

POTENTIAL APPLICATIONS AT NCTD

Application Area	Recommended Development Environment	Software for Implementation	NCTD Priority
Financial Areas			
Grant Accounting and Tracking	Enhancement to mini system	COBOL	Medium
On-line Purchasing (GMC Rapid)	Microcomputer (Maint Dept)	Communications package	Low
Performance Reporting	Enhancement to mini system	COBOL	Medium
Personnel Areas			
Employee Personnel Administration	Microcomputer (Personnel Dept)	DBMS	High
Monthly Labor Reporting	Enhancement to mini system	COBOL	Low
Applicant Tracking	Microcomputer (Personnel Dept.)	DBMS	Low
Maintenance Areas			
Maintenance Timekeeping	Microcomputer (Maint Dept)	DBMS	Medium
Maintenance Trend Analysis	Enhancement to mini system or Microcomputer (Maint Dept.)	COBOL DBMS	Low
Consumables Analysis	Hold decision pending decision on automated fueling system		Low
Building Maintenanance Administration	Micro (Maint Dept)	DBMS	Low
Oil Analysis Tracking	Micro (Maint Dept) or enhancement to mini system	DBMS COBOL	Medium Medium
Safety Meeting Attendance Monitoring	Micro (Maint Dept)	DBMS	Low
Supervisor Personnel Administration	Micro (Maint Dept)	DBMS	Low

TABLE 2 (Continued)

POTENTIAL APPLICATIONS AT NCTD

Application Area	Recommended Development Environment	Software for Implementation	NCTD Priority
Bad Order Tracking	Micro (Maint Dept), revised work order input to vehicle maintenance system on minicomputer	DBMS and Screen generator	High
Small Tools Inventory Control	Micro (Maint Dept)	DBMS	Medium
Maintenance Performance Reporting	Enhancement to mini system	COBOL	High
Operations Areas			
Operator Personnel Administration	Micro (Operations Dept)	DBMS	High
Accident Tracking and Reporting	Micro (Operations Dept)	DBMS	Low
Planning and Marketing Areas			
Ridership Reporting	Micro (Planning and Marketing Dept)	Adapt existing software, Spreadsheet, or, DBMS and screen generator	High
Survey Analysis	Micro (Planning and Marketing Dept)	Statistical Package	Medium

and tracking, purchasing, and performance reporting.

Grant Accounting and Tracking

NCTD currently performs all administration of grants manually, including accounting, scheduling, performance monitoring, and external reporting to funding sources. The functions which NCTD would like to consider for implementation on a computer are listed below.

- Grant accounting: Grants are not currently accommodated in the general ledger on the microcomputer; all accounting processing is manual. All grant projects, capital, technical study, and planning, are monitored by approved budget line item, and expenditures must be tracked by each item. Expenditures (staff labor expense, fringe benefits, overhead items, and payables) are captured in the regular operating accounting system, but no financial reporting is provided explicitly for grants. NCTD would like to automatically track expenditures versus budget line item for each grant and generate reports for each grant, including financial statments for each grant, financial statements for each funding source, quarterly progress reports, fund requisitions, and special reports required for California Transportation Development Act (TDA) funding.

- Grant tracking: NCTD would like to track grant progress using project tracking tecniques, such as PERT charts.

- Disadvantaged Business Enterprise / Women Business Enterprise tracking: All grants require that grantees meet goals for allocation of grant funds to designated Disadvantaged Business Enterprises (DBE) and Women Business Enterprise (WBE) companies. NCTD would like to automatically capture and track all expenditures paid out to DBE and WBE companies for purchases and services, with reporting to show DBE and WBE expenditures, classified as required by funding source.

Grant accounting and tracking should be implemented as an enhancement to the existing minicomputer system because much of the information required and the structure itself is already

present on the existing system. Most grant expenses are already captured by the payroll and accounts payable programs. Additional functions would have to be added to capture and classify DBE and WBE expenditures, but this would more easily be accomplished within the existing system rather than formatting and passing all information to another computer. Accounting for grants could be structured along the same lines as the existing accounting system for operations. New reports would have to be designed and implemented to meet external reporting requirements for grants. The existing accounting system would have to be modified to perform distribution of joint expenses and overhead items to operating and grant funds, but again, this would most easily be accomplished within the existing system.

Purchasing -- GMC Rapid System

NCTD is considering subscribing to the GMC Rapid System, the on-line parts ordering system offered by the General Motors Corporation (GMC) Parts Division. The system allows subscribers who have their own computer to dial into the GMC system to check the GMC parts list for part numbers and prices, to place orders, and to monitor the status on orders placed. The major advantages are access to the most up to date GMC parts list and expedited order processing. While the system would be easy and inexpensive to implement at NCTD, it offers little advantage. Most of the coaches in NCTD's fleet are not GMC coaches, and most of the parts ordered for the GMC coaches themselves are ordered through other part fabricators, who are generally less expensive than GMC. Rapid can always be tested on a trial basis should NCTD wish to subscribe, since no development is involved, and cost for use of the system is based on usage; minimal use will result in minimal expense.

Any microcomputer will suffice as a terminal, and NCTD will likely be acquiring one or more microcomputers, as recommended in this report.

Performance Reporting

NCTD would like to generate regular performance reports, both for its own use and for external reporting required by the State of California. Performance reporting involves capture of data already available, synthesizing information, and generating reports. Most performance reports would be generated on a monthly basis, so monthly data would be required. Revenue and expense information is available from the existing general ledger system. Measures likely to be used for this analysis would include total vehicle miles, revenue vehicle miles, vehicle hours, operator pay hours, number of equivalent full time employees (total and by department), and number of peak vehicles.

Performance reporting would also best be implemented as an enhancement to the existing minicomputer system, again because most of the already exists in files on the existing minicomputer system.

Personnel Applications

Three application areas were discussed for potential implementation at NCTD in the personnel area: employee personnel administration, monthly labor reporting, and applicant tracking. Another related personnel application area, operator personnel administration, is discussed in the operations section.

Employee Personnel Administration

The personnel module of the payroll system on the existing minicomputer system provides only very basic personnel information and functional use. NCTD would like to supplement

the basic information to facilitate administration of personnel functions. These requested enhanced capabilities are summarized below.

- Employee master file information: A personnel system would require base information for each employee, including name, address, telephone, emergency contact, date of birth, date of hire, length of service credited, company benefits provided, voluntary benefits subscribed, education, department, position, and affirmative action classification. Any new system would have to provide for the addition of new pieces of information not currently identified or foreseen.

- Affirmative Action / Equal Employment Opportunity reporting: NCTD would like to be able to automatically generate Affirmative Action and Equal Employment Opportunity reports required by Federal and State governments to ensure compliance with regulations. Current reports require counts of employees by affirmative action classification and position classification. NCTD would also like to obtain reports of affirmative action classification for applicants, new hires, and terminations.

- Salary history tracking: In addition to the base information listed above, the capture of each salary change would permit generation of a history by employee, would provide information to evaluate salary decisions, and could be available for correlation with other information for analysis.

- Disciplinary action tracking: In addition to the base information listed above, the capture of disciplinary action administered would be useful to evaluate employee performance and to determine the effectiveness of incentive or deterrent efforts. Reports would generate summary statistics and individual employee disciplinary history.

- Training history tracking: The capture of all training activity would serve to evaluate the effectiveness of training and would help administer training assignments. Reports would generate summary statistics and individual employee or department training history.

- Analysis of merit pay: NCTD would like to track merit pay awards to facilitate administration of the awards and to determine the effectiveness of awards. Reports would include merit pay history for individual employees and summary reports showing correlation between merit pay awards and performance.

Although some personnel information is currently available on the existing minicomputer system, Multisystems recommends that NCTD develop an employee personnel administration program on a microcomputer. There are two primary reasons for this recommendation. First, there are applications development tools more readily available on microcomputer systems than on the existing minicomputer system, and thus this application could more easily be developed on a microcomputer. The applications development tool which readily lends itself to this application is a data base management system (DBMS), which is discussed in the next section. Second, there will likely be changes and additions to NCTD's functional requirements for employee personnel administration, and changes can more easily be accommodated using a microcomputer data base management system. Typically, reports can easily be developed and modified using such a system. The disadvantage to the microcomputer approach for employee personnel administration is that all information required by the existing minicomputer system might have to be entered twice, but this is not likely to be a large volume of information.

Monthly Labor Reporting

The existing minicomputer system currently generates a monthly labor report, but NCTD would like to improve the report. Improvements requested include reporting by job classification, reporting by EEO code and by sex, and generation of statistics on turnovers, new hires, and terminations. These would likely best be accomplished by modifiying the existing program which generates the monthly labor report. However, if all inforamtion is to be captured in

an employee personnel administration system on a microcomputer, as recommended, it would likely be easier and faster to design and develop a new set of monthly labor reports on the new system. Generation of reports using a data base management system is facilitated by the use of a report generator which would be included in the DBMS. Typical report generators provide rapid and relatively easy generation of both regular production reports and ad-hoc reports generated on an as needed basis.

Applicant Tracking

The existing minicomputer system has an applicant tracking system, but it is inadequate for NCTD requirements. NCTD currently receives between 2,000 and 4,000 applications annually. The current system identifies applicants and base information for each applicant. Enhancements requested include capture and tracking of interview and evaluation information, maintenance of candidate eligibility lists, tracking of disposition of candidates, and generation of statistical reports on recruitment and hiring. An applicant tracking program is available on the minicomputer for about $2,500, but all of NCTD's requirments would still likely not be met. Multisystems recommends that applicant tracking be developed using a DBMS on a microcomputer. This program would be developed in conjunction with and integrated the employee personnel administration application software.

Maintenance Applications

Ten application areas were discussed for potential implementation at NCTD in the maintenance area: maintenance timekeeping, maintenance trend analysis, consumables analysis, building maintenance administration, oil analysis tracking, safety meeting attendance monitoring, supervisor personnel administration, bad order tracking, small tools inventory control, and maintenance performance reporting.

One maintenance application area which was neither discussed nor currently implemented on the existing minicomputer system was parts inventory control. NCTD is currently planning to adapt a parts inventory control software package, probably on the minicomputer, but a current course of action has not been determined. Implementation on a microcomputer would be possible, since software is readily available for adaptation as a vehicle maintenance parts inventory. However, it would be a large application which would require a dedicated microcomputer. Implementation on the existing minicomputer system would facilitate an interface with the existing vehicle maintenance system, if this is required.

Maintenance Timekeeping

Maintenance payroll is generated for maintenance employees on the existing minicomputer system, as it is for all NCTD employees. However, the Manager of Maintenance would like to capture and use more detailed maintenance labor information to monitor maintenance activities and better manage maintenance labor resources. The maintenance department has about 90 employees. One possibility would be to capture maintenance payroll input on work orders, but all manintenance labor input would have to be captured to meet requirements for both payroll input and work order labor reporting.

NCTD would like to have reports on the utilization of maintenance labor, including productivity reporting, reporting of absences and tardiness by classification, and standards for different types of jobs. Information would be used by supervisors to assign maintenance work and administer disciplinary action. The current maintenance labor reports are generated for each payroll period, which is biweekly, and cannot be integrated with reports and statistics from the vehicle maintenance system, which are on a monthly cycle.

It would be preferable to make enhancements to the existing minicomputer system to develop maintenance timekeeping and reporting inputs and reports to meet the NCTD requirements. Much of the information required already exists in the existing system.

However, most of the development required would be more easily accomplished on a microcomputer using development tools more readily available and usable on such a system, such as screen generators, report generators, and data base management systems. The best solution would be to develop a maintenance timekeeping system, probably including work order input, on a standalone maintenance microcomputer and provide interfaces with the existing minicomputer as necessary. The microcomputer system would serve as a "front end" and provide input to both the existing maintenance payroll and vehicle maintenance systems. Attention must be paid to ensure that any microcomputer hardware and software permit a smooth interface with the existing minicomputer system. The interface would likely include transfer of files between the two systems (i.e., passing a payroll input file from the maintenance microcomputer to the minicomputer) and on line access to information in files (i.e., microcomputer access to maintenance employee information on the minicomputer). The maintenance department could also use the information to develop its own set of maintnenance reports for productivity reporting, detailed absenteeism reporting, and development of job standards.

Maintenance Trend Analysis

NCTD would like to use existing outputs from the vehicle maintnenance system to generate additional reports and graphics to obtain more meaningful information about maintenance problems and performance. Some trend analysis is currently performed manually using existing outputs from the vehicle maintenance system.

This would likely best be accomplished on the existing minicomputer, since all information necessary to do so is already available. However, it might be easier to pass a file or set of files each month from the vehicle maintenance system to a maintenance microcomputer, where the maintenance department itself could formulate, generate, and control its own trend analysis and supplemental maintenance reporting. As discussed above, software to support this type of development and use is more readily available on a microcomputer than on the existing minicomputer system. For this particular application, NCTD would use a communications software package, a report generator, and a graphics package, all of which are readily available. The comments above concerning interface with the existing minicomputer system apply here as well.

Consumables Analysis

The existing vehicle maintenance system does not capture or provide an analysis of consumable liquids, such as diesel fuel, engine oil, transmission fluid, power steering fluid, and engine coolant. Many properties use liquid consumption, primarily fuel and oil consumption, as an indicator of problems for a given coach or fleet. Such an analysis can be used not only to spot a particular problem but also to suggest how to solve the problem. NCTD currently manually monitors a small sample of vehicles refueled each day; no consistent analysis is possible for the entire fleet. Ideally, all fueling would be captured and entered into vehicle histories. Reports would inlcude consumption statistics by vehicle and fleet and trend analysis.

NCTD is currently considering implementing one of the automated fueling systems currently on the market, whereby fueling and odometer readings are entered into a computer at the servicing facility. Most systems are standalone and generate reports on the fueling operation only; some provide interfaces with vehicle maintenance systems on other computers.

The development of a consumables analysis system could readily be implemented on a maintenance microcomputer. The advantage of such a system is that NCTD could generate a consumables analysis to its specifications using productivity tools, as mentioned above. Interfaces could be created with both an automated fueling system and the existing vehicle maintenance system. Such a microcomputer system could even serve naturally as the "bridge" between the two. However, the design and development of such a system should be performed in conjunction with the implementation of the automated system to ensure compatiblity of hardware and software.

Building Maintenance Administration

NCTD would like to administer maintenance of buildings and grounds in much the same way vehicle maintenance administration is performed. Each facility should have its own maintenance history and its own preventive maintenance schedule. Maintenance schedules are not so precisely defined or consistent for the variety of fixed facilities, however. NCTD would like to capture and track subcontractor activity on buildings and grounds. Reports would include maitenenance scheduling, maintenance histories, subcontractor performance reports, cost analysis, and trend analysis on activities performed and costs incurred.

This application readily lends itself to implementation on a microcomputer using a data base management system. NCTD could define and implement its own design specifications, screen inputs, and reports to be generated using its own resources. Specifications could then be changed as desired without outside assistance.

Oil Analysis Tracking

NCTD currently has oil analysis performed on engine oil samples on a regular basis by an outside laboratory service. About 1300 samples are analyzed and reported annually. NCTD

would like to maintain a computer file of all samples and use the file to generate individual sample reports, perform analyses of vehicle types, and generate a trend analysis for individual vehicles. The laboratory service offers transmission of results directly via telephone line to a user's computer, so data entry could be avoided.

Oil analysis tracking could also be performed on a microcomputer more easily than on the existing minicomputer, although results could be passed on to vehicle histories in the vehicle maintenance system. Modems and software are available which permit any popular microcomputer to communicate with most mainframes, at least to the extent that files such as the test results from an oil analysis sample can easily be transmitted. The analysis itself could be developed to NCTD specifications using a data base management system, as discussed above. A communications software package and a modem would be required.

Safety Meeting Attendance Monitoring

NCTD would like to monitor attendance at safety meetings by attendee and by topic. This is a simple application on a microcomputer using a data base management system. Queries and reports could be generated to determine safety meeting attendance by individual mechanic and by topic. However, this application might also be incorporated into a more comprehensive maintenance personnel administration application similar to the operator personnel administration discussed in the next section.

Supervisor Personnel Administration

NCTD would like to monitor the attendance, performance, and disciplinary record of supervisors to facilitate the administration of its program of merit pay for supervisors. This application would also best be implemented and maintained on a maintenance microcomputer. The development would be

facilitated on a microcomputer, but an interface with the existing minicomputer system would be required. The recordkeeping and reporting itself would be similar to the operator personnel administration application described in the next section. The design of the data base would be similar, but specific information would be different. Performance reporting for supervisors would, in addition, require productivity measures, which would be derived from vehicle maintenance activities tracked and reported in the vehicle maintenance system on the existing minicomputer system. A file of activities would have to be passed to the microcomputer.

Bad Order Tracking

The current vehicle maintenance system tracks repairs performed but does not capture the reporting of problems themselves. NCTD would like to track problems reported on operator defect cards and the disposition of each problem to attempt to spot problem vehicles, specific types of problems, or ineffective maintenance procedures to address problems.

This application should be incorporated into a new "front end" work order input design for the vehicle maintenance system, should NCTD wish to proceed with modification of input to the existing system. This application would be easiest to accomplish on a microcomputer using a screen generator package, either as part of a data base management system or as a separate package. It should be implemented on a microcomputer only if a new work order input to the vehicle maintenance system is also implemented and integrated with this application. The use of a data base management system on a microcomputer would enable NCTD to track and analyze problems reported according to user specifications for aggregations of data, report formats, and statistics to be generated.

Small Tools Inventory Control

NCTD would like to maintain an inventory of small tools because of the difficulty in maintaining control of such tools and the direct accountability of mechanics required. The inventory would inlcude a list, description, value, and mechanic responsible for each tool. The application readily lends itself to implementation on a microcomputer using a data base management system. NCTD could design, develop, implement, and enhance a simple small tools inventory control application without any outside assistance.

Maintenance Performance Reporting

NCTD would like to do more meaningful maintenance performance reporting than is currently possible with the existing vehicle maintenance system. The vehicle maintenance reports currently produced are useful so far as they go. NCTD would like to generate performance reports based on performance indicators on a regular basis. Analysis would include a "cost per mile" analysis for various cost categories by vehicle and by fleet.

NCTD would like to make the existing reports useful rather than developing a new system. Most of the data necessary to generate the maintenance performance reports requested is available on the existing minicomputer system but in different modules of the existing system. This application should be developed as an enhancement to the existing minicomputer system by synthesizing information from the different sources: cost information from the accounting system by specified maintenance categories and vehicle maintenance activity from the vehicle maintenance system by specified categories. Reports would be programmed using the data from these sources.

Operations Applications

Two application areas were discussed for potential implementation at NCTD in the operations area: operator

personnel administration and accident tracking and reporting.

Operator Personnel Administration

The operations department has a need for personnel inforamtion that is more specialized than the general personnel information available either within the payroll program on the existing minicomputer system or the more detailed employee personnel system outlined above in the personnel section. The functions requested for operator personnel administration at NCTD are summarized below.

- Operator master file information: Each operator would have base information in a master file; base information would include any information for which the same piece of data and the same volume of data is required for each operator. This information would include name, employee number, seniority number, seniority date, date of hire, date of medical certification, and driver's license expiration date. This information could be used in any operator personnel report for either classification or use on a report itself. The system would have to provide for the addition of new pieces of information not currently identified or foreseen.

- Disciplinary action tracking: In addition to the base information listed above, the capture of disciplinary action administered would be useful to evaluate operator performance and to provide data to determine future disciplinary action. Some discliplinary action information would be captured for all NCTD employees, as described above, but operator disciplinary information would be specific to operations and used specifically by operations management. Frequency and type of infractions and disciplinary action awarded are factors in determining further disciplinary action or management attention warranted in a given situation.

- Sick pay administration: The payroll system is used to pay sick pay, but it is not sophisticated enough to determine if sick pay is to be paid for a given operator in a given situation. NCTD's labor agreement calls for sick pay to be paid or not depending on several factors, including operator seniority, sick days accrued, sick days

taken withing a certain length of time, unpaid sick days taken within a certain length of time, and proximity of a candidate sick day to an operator's day off. While it would be unreasonable to develop a program to make a decision whether sick pay is to be paid or not in a given situation, a program could reasonably be developed to track and report all information which is used to make the decision. Thus, this information could be recalled by a dispatcher as necessary for the dispatcher to make a pay or no pay decision. The dispatcher would also input the information for a given occurrence (operator, date, sick day, and paid / not paid decision).

- Absenteeism tracking: In addition to sick pay, NCTD would like to track and report on other unscheduled absences, including days off without pay, jury duty, national guard duty, and bereavement leave, principally to determine if any are being abused.

- Complaints and commendations tracking and reporting: NCTD would like to track occurrences of complaints, and commendations for each operator, to be used for evaluation of operator performance and for administration of operator discipline. This information is currently tracked manually, but an automated system might be more readily available and provide more useful analytical results.

Operator personnel information would best be implemented on an operations microcomputer. As with previous applications discussed, there are applications development tools more readily available on microcomputer systems than on the existing minicomputer system, and thus this application could more easily be developed on a microcomputer. There will likely be changes and additions to NCTD's functional requirements for operator personnel administration, and changes can more easily be accommodated using a microcomputer data base management system. Typically, reports can easily be developed and modified using such a system.

Accident Tracking and Reporting:

NCTD currently maintains manual records of accidents, but an automated file of accidents might permit analysis of

accidents to determine problem operators, locations, accident types, or vehicles. Accident reports would be used with the operator personnel information listed above to evaluate operator performance and as one element in the administration of operator discipline.

Accident tracking and reporting could also be implemented on an operations microcomputer. A data base management system would be used to develop this application as well. The usefulness of reports on accidents would be limited to information which could be encoded for input to the computer.

Planning and Marketing Applications

Two application areas were discussed for potential implementation at NCTD in the planning and marketing area: ridership reporting and survey analysis.

Ridership Reporting

NCTD currently derives ridership statistics manually from operator time cards. A dispatcher aggregates information from each operator time card on a daily recap sheet, from which a daily ridership report is prepared. Monthly ridership reports are generated from an aggregation of daily ridership reports. Ridership is reported by route and system total but not by fare classification. The automation of ridership reporting would not only relieve dispatchers and clerks of tedious manual calculation and report preparation, but it would also permit the generation of additional reports, such as detailed route analysis or analysis of ridership by day of week.

There are software packages being used for this purpose which run on microcomputers. However, each transit property's procedures and requirements tend to vary, and modifications may or not be possible or easy with any given package. Still, NCTD should investigate the use of one of the available packages in

addition to developing its own software. The packages include the following:

- Route performance and cost analysis program, developed the Capital District Transportation Authority (CDTA), Albany, NY;
- Transit Information Manager, developed for UMTA by Multisystems; and
- Revenue and ridership processing and reporting program being developed by Multisystems for Wisconsin Department of Transportation.

All of these are available with no license fees, but the effort to adapt any program to specific NCTD needs could be greater than the effort necessary for NCTD to develop its own system to its own specifications with a data base management system or a spreadsheet program. The main criteria for determining whether to adapt or develop is whether NCTD's input from daily operator cards can be accommodated by any given program. A spreadsheet package, which is easier for a non-programmer to use than a data base management system, could be used for this purpose. However, a DBMS would permit easier aggregation of data for monthly reports, customized screen design to replicate forms used, and generation of more meaningful reports. The application could and should be developed and implemented on a microcomputer in any case.

Survey Analysis

NCTD currently uses staff from San Diego County Association of Governments (SANDAG), the metropolitan planning organization for the county, to conduct and analyze its on-board surveys, including surveys required for the Section 15 service consumed schedule. NCTD would like to have the capability to process its own survey data in-house.

NCTD could perform statistical analysis on its existing minicomputer system or on a standalone microcomputer. Packages are available for either system. NCTD currently has a limited

statistical processing package on its minicomputer. Statpac, Statpro, and Abstat (see recommended software section below) are two general purpose statistical processing packages available on a microcomputer. The Transit Information Manager, mentioned in the operations applications section, can be used to process and analyze point checks, ride checks, and Section 15 surveys. Specific software recommendations should be made after the requirements for this application (actually several applications) are better defined. NCTD should then check on the software packages mentioned above to see if any might be suitable to meet these requirements.

IV. RECOMMENDATION FOR MICROCOMPUTER IMPLEMENTATION AT NCTD

This report recommends that NCTD continue its computer system development (a) by implementing several enhancements to its existing minicomputer system and (b) by acquiring up to four microcomputers and implementing applications on the microcomputers. This section discusses the recommended hardware and the procedure to select the major software to be used for implementation of the NCTD applications, a data base management system package.

The applications recommended for implementation at NCTD are listed in Table 2. Several applications are logical extensions of the existing minicomputer and therefore should be implemented on the minicomputer as enhancements to the existing system. These include grant accounting and tracking, performance reporting, maintenance performance reporting, monthly labor reporting, maintenance trend analysis, and oil analysis tracking. The last three could also be implemented on microcomputers, and the decision for each should be based on the status of other programs being developed on the minicomputer and the relative priority for each application. The NCTD consultant and programmer/operator should be consulted to provide input to these decisions.

This report recommends twelve applications for implementation on microcomputers, as noted in Table 2. Some are very simple applications which NCTD could easily implement without outside assistance, including purchasing (the GMC Rapid system), safety meeting attendance monitoring, and small tools inventory control. Most others are major applications involving design, development, implementation, training, and documentation efforts. The implementation would be facilitated by the use of a data base management system (DBMS) and a screen generator package, either as a part of the DBMS package or a separate package. The use of a DBMS for applications development is well within the capabilities of the NCTD programmer/operator, and most of the applications could be developed reasonably quickly, once the use of the DBMS has been mastered. Key NCTD staff members could learn to use those parts of the DBMS package to permit implementation of simple applications.

Recommendation for Microcomputer System

NCTD should acquire up to four microcomputers to implement the applications listed in Table 2. One each would be located in the personnel, maintenance (suitable maintenance administration office), operations (Oceanside), and planning and marketing departments. Not all computers need be acquired at once, since not all applications could be developed simultaneously. The specific sequence would depend on the priority sequence for applications to be developed. Departments could share initially, with new computers procured as the demand indicated. Two computers are recommended for initial implementation, probably located in the maintenance department and one in a central office location for common use by the finance, personnel, and planning and marketing departments. Applications for the operations department could be developed on one of these computers, and the operations

department computer itself could be acquired when these were ready for production use.

Multisystems recommends that NCTD acquire Texas Instruments Professional Computers (TI PC) exclusively. The computer is a powerful, well configured, full featured, and cost effective microcomputer. Its main virtue for NCTD is that the TI PC would have the capability to communicate with NCTD's existing minicomputer, which is a Texas Instruments 990/12. Although other microcomputers could also communicate with the TI 990/12, the TI PC would be able to do so in more situations than any other microcomputer. As discussed in the previous section, most of the communications would be simple file transfers back and forth, but it would be desirable to be able to use the microcomputer as a regular on-line terminal on the minicomputer, which the TI PC would be able to do. Service on a TI PC could be obtained from the same service contractor used for the existing minicomputer system.

The only potential disadvantage of the TI PC is that other microcomputers, notably the IBM Personal Computer and its "lookalikes" which claim compatibility with it, can run more existing software than the TI PC. However, NCTD does not have a need for a large body of software, only selected software which should be readily available.

The TI PC is described in the Texas Instruments Professional Computer Characteristics Guide include in the Appendix. The standard system configuration for the computer includes the system unit, the keyboard, and the display unit. The system unit includes the central processing unit, random access memory, the diskette drive(s), expansion card slots to accommodate circuit board "cards" for interfaces with external devices, and controller boards for connections to the keyboard, display, and printers. Multisystems recommends that the full 256K memory be acquired immediately to enable any program to be run.

Multisystems also recommends that each computer acquired have a hard disk, either the 10 megabyte Winchester drive that TI incorporates within the system unit or an external hard disk which will use one of the expansion card slots. The disk incorporated in the system unit is likely to be the least expensive, but the external disk offers other advantages. The external disk we recommend is an Iomega disk drive unit, which features 20 megabytes of disk storage, 10 megabytes on each of two disk drives. Its advantage is that all storage is on removable disks (just like a diskette), such that backup is immediate (on a removable disk), and there is no limit to the amount of storage provided because disks can be removed and stored. The disks installed in the drive provide on-line storage available for processing, just as the internal Winchester disk drive provides.

Texas Instruments offers two display units, a monochrome monitor which can display only characters and a color display which offers high resolution graphics capability, in addition to regular character display. Multisystems recommends that at least one of the initial computers have the graphics capability so that graphics programs can be run at NCTD.

Texas Instruments offers its own line of printers, although all popular printers operate satisfactorily with a TI PC. NCTD has no need for an exclusively letter quality printer, because all correspondence is generated on the word processing system. There may be occasional need, however, for reasonably high quality printer output from the TI PC's, so at least one so-called "correspondence quality" dot matrix printer is recommended. TI's Model 855 qualifies, but its carriage width of 11 inches may be limiting because it cannot print on "computer width" paper (15 inches). Should a combination correspondence and draft quality dot matrix printer be advisable for NCTD needs, we recommend the Toshiba 1351 printer. For high speed draft quality (the vast majority of

NCTD's printing needs), the TI Model 810 is suitable. The Epson product line also has recommended printers.

NCTD will require one or more modems to provide connections to computers at other locations. Modems may be required to connect the NCTD microcomputers, notably the maintenance microcomputer, to the existing minicomputer system, but this might also be accomplished with a hardwire connection. The company providing maintenance on the minicomputer would best be able to determine the appropriate configuration.

Recommendation for Software

NCTD should acquire a spreadsheet software package, a data base management system package, and one or more of the specialized software packages described in the applications section. While no applications have been identified which specifically use a spreadsheet package, anyone who has ever learned to use a spreadsheet package has found many uses for it. Typical uses on a transit property have included development of operating budgets, calculation of scheduled vehicle miles and hours by route, and daily ridership processing. Multisystems recommends that NCTD acquire the Lotus 1-2-3 package for its spreadsheet. This package combines spreadsheet processing, generation of graphics, and a simple data base management system. It has powerful spreadsheet capabilities, yet is easy to learn and use.

NCTD will derive the most benefit from its microcomputers by developing its applications using a data base management system (DBMS) package. Although there are many DBMS packages available, only a few are suitable for the level of applications development which should occur at NCTD. The class of packages discussed in this section occupies a unique position in programs. Because of the power required for applications development, they are not so called "user friendly" packages. However, they can be used by people other than programmers to develop applications which themselves are

user friendly, that is very easy for any non-programmer to use. Applications can typically be developed in a fraction of the time formerly required to program in traditional programming languages such as COBOL or FORTRAN.

Generally, a data base management system will allow a non-programmer to define a file structure, to design procedures to enter data into files, and to design procedures to extract data from files. Most DBMS packages are intended for people who want to develop simple applications without the need for outside programming assistance. In most such cases, the program developer is also the program user, although there could certainly be additional users. The simplest DBMS packages allow a program developer to use only one file at a time, restrict the ability of the developer to define how data are to be entered into the file, restrict how data can be manipulated, and have limited capabilities to generate reports.

As DBMS packages increase in sophistication and power, more applications can be developed, but the program developer needs to learn more about "programming." Still, applications can be developed without outside programming assistance. The more powerful DBMS packages permit developers to design custom screens for user input and display of data, to edit user input, to use one screen to enter data in several files, to manipulate data depending on user input, to create menus to make programs easy for users to use, to protect programs with passwords, to create more complex reports, to use data from several files to generate a single report, and to use larger and more complex files.

There are several DBMS packages which could be used to develop the NCTD applications on microcomputers. This report recommends several candidate packages but not a specific package, because the staff member (or members) to be responsible for development of most of the applications should be involved in the selection. Table 3 presents a checklist for DBMS package selection for use in applications development.

TABLE 3

DATA BASE MANAGEMENT SYSTEM EVALUATION CHECKLIST

NAME OF DBMS: _____

VENDOR NAME: _____ LOCAL DISTRIBUTOR NAME: _____

ADDRESS: _____ ADDRESS: _____

_____ _____

PHONE: _____ PHONE: _____

USER SUPPORT: TELEPHONE HOTLINE: _____ SUBSCRIPTION MAINTENANCE AVAILABLE: _____

OPERATING ENVIRONMENT: TEXAS INSTRUMENTS PROFESSIONAL COMPUTER USING MS-DOS: _____

DEMONSTRATION DISK TO SHOW FEATURES? _____

NCTD STAFF USE OF APPLICATIONS DEVELOPED WITH DBMS:

- USE OF MENUS: _____
- USE OF SCREENS DESIGNED WITH DBMS: _____
- SCREEN HANDLING WITH DBMS: _____
- QUERY CAPABILITY FOR NOVICE USER: _____
- INPUT OF FILES FROM OTHER PROGRAMS FOR NOVICE USER:

  _____
- GENERATION OF REPORTS BY NOVICE USER:
  - MENU SELECTION OR PROMPTS: _____
  - ABILITY TO CONTROL LINE BREAKS AND PAGE BREAKS: _____
  - ABILITY TO SELECT INFORMATION TO BE INCLUDED: _____
  - ABIILITY TO FORMAT REPORT: _____
- DOCUMENTATION EVALUATION FOR APPLICATIONS USER: _____
- PASSWORD PROTECTION BY USER: _____

USE OF DBMS FOR APPLICATIONS DEVLOPMENT

- DESIGN OF MENUS FOR USERS: _____
- SCREEN DESIGN FOR USER INPUT:
  - CUSTOM DESIGN OF SCREENS TO MATCH FORMS: _____
  - DATA CHECKING: _____
  - DISTIBUTION OF INPUT DATA TO MULTIPLE FILES: _____
- PROGRAMMING CAPABILITY:
  - CONDITIONAL BRANCHING: _____
  - CONTROL OF CURSOR ON SCREEN ACCORDING TO USER INPUT: _____
  - DATA CHECKING: _____
  - ERROR CHECKING AND USER MESSAGES: _____
  - CONTROL OF DISTRIBUTION DATA TO FILES: _____
  - BATCH PROCESSING: _____
  - INDEXES FOR FILES, NUMBER AND USE: _____
- INTERFACE WITH OTHER SOFTWARE:
  - USE OF FILES FROM OTHER SOFTWARE: _____
  - OUTPUT OF FILES FOR USE BY OTHER SOFTWARE: _____

TABLE 3 (Continued)

DATA BASE MANAGEMENT SYSTEM EVALUATION CHECKLIST

SETTING UP REPORTS FOR USERS:
- REPORT FORMATTING CONTROL: _____
- MULTIPLE LINES ON REPORT: _____
- RETRIEVAL CAPABILITY FOR REPORT DATA, FILES: _____
- SORTING CAPABILITY: _____
- CONTROL OF SELECTION OF DATA FOR REPORT: _____
- CONTROL OF LINE BREAKS AND PAGE BREAKS: _____
- STATISTICS AVAILABLE FOR REPORTING _____

DOCUMENTATION EVALUATION FOR APPLICATIONS DEVELOPER: _____

SETTING PASSWORD PROTECTION: _____

DBMS CAPACITIES:
- FILES AVAILABLE SIMULTANEOUSLY: _____
- MAXIMUM RECORDS IN FILE: _____
- MAXIMUM RECORD LENGTH: _____
- MAXIMUM FIELD LENGTH: _____
- MAXIMUM NUMBER OF INDEXES: _____

Table 4 lists candidate DBMS packages for consideration for applications development at NCTD.

NCTD (or a consultant) should perform a brief evaluation of each package. The evaluation must consider a package's use both by a developer of applications and by staff who will use the applications thus developed. The evaluation should include research of available literature, evaluation of a demonstration of the package, and evaluation of the package documentation. Information can be obtained from dealers of each package, many of whom are local retail computer stores. Most packages have a demonstration disk which shows features and use of the package. The documentation should be understandable for both the system developer and the staff who will use it for production applications. Note that not all of these packages necessarily run on a TI PC, so this should be the first item to check.

NCTD should begin development with the DBMS with one of the easiest applications, such as safety meeting attendance monitoring or small tools inventory control. This would enable both the applications developer and application user to "test drive" the DBMS. This may lead to the decision that another DBMS should be selected perhaps because the initial selection was deemed to have inadequate capabilities or was too difficult to use. At that point, however, the investment in the DBMS (typically under $800) would not be so great that the decision could be changed. Should the initial selection be confirmed, the simple application will provide initial training for both the developer and application user.

Some of the more sophisticated applications may require data input screens which may be more complex than can be accommodated with the screen generator within the DBMS. Most, for example, cannot accommodate multiple lines of information which are to be entered into multiple records in several files. This might be a restriction on detailed inputs, such as work order inputs. A standalone screen generator package is

TABLE 4

CANDIDATE DATA BASE MANAGEMENT SYSTEMS FOR NCTD APPLICATIONS DEVELOPMENT

Data Base Management System	Developer / Vendor Name and Address	Developer / Vendor Telephone
Advanced DB Master	Stoneware, Inc. 50 Belvedere Street San Rafael, CA 94901	(415) 454-6500
Aladin	Advanced Data Institute, Inc. 1215 Howe Avenue Sacramento, CA 95825	(916) 925-2229
Condor Series 20, Level III	Condor Computer Corporation 2051 South State Street Ann Arbor, MI 48104	(313) 769-3988
DataFlex	Data Access Corporation 8525 S.W. 129th Terrace Miami, FL 33156	(305) 238-0012
Framework	Ashton-Tate Corportation 10150 West Jefferson Blvd. Culver City, CA 90230	(213) 204-5570
Informix	Relational Database Systems,Inc. 2471 East Bayshore Road Palo Alto, CA 94303	(415) 424-6500
Knowledge Man	Micro Data Base Systems, Inc. P.O. Box 248 Lafayette, IN 47902	(317) 463-2581
Optimum Data Management System	Uveon Computer Systems, Inc. 899 Logan Street #111 Denver, CO 80203	(303) 831-7000
Oracle	Oracle Corporation 2710 Sand Hill Road Menlo Park, CA 94025	(415) 854-7350
PC/FOCUS	Information Builders, Inc. 1250 Broadway New York, NY 10001	(212) 736-4433
R:Base 4000	MicroRim 1750 112th N.E. Bellevue, WA 98004	(206) 453-6017

TABLE 4 (Continued)

CANDIDATE DATA BASE MANAGEMENT SYSTEMS FOR NCTD APPLICATIONS DEVELOPMENT

Data Base Management System	Developer / Vendor Name and Address	Developer / Vendor Telephone
Revelation	Cosmos, Inc. 19530 Pacific Highway South Seattle, WA 98188	(206) 824-9942
Savvy	Excalibur Technologies P.O. Box 26448 Albuquerque, NM 87125	(505) 242-3333

recommended for implementing such applications. Applications which might require a screen generator for data input and display include bad order tracking and ridership reporting. Should work order input be enhanced to include maintenance payroll input, the maintenance timekeeping application would also likely be implemented with a screen generator package. Multisystems recommends the use of the Panel screen generator package from Lifeboat Associates (212-860-0300) for this purpose.

Communications software is required to enable communications between computers via modems or hardwire connection. This software is required to establish protocols between computers to ensure that sending and receiving computers are communicating in the same mode. The software also performs the actual transfer of data to or from the microcomputer into or from the sending device. Texas Instruments offers its own communications software for this purpose.

NCTD should acquire a statistical package for use on microcomputers if survey analysis is to be performed in-house. One of the following three packages should be considered for this purpose:

- Statpac Walonick Associates
  5624 Girard Avenue,
  Minneapolis, MN 55419
  (612) 866-9022

- Statpro Wadsworth Electronic Purblishing Company
  Statler Office Building
  20 Park Plaza
  Boston, MA 02116
  (800) 322-2208

- Abstat Anderson-Bell
  P.O. Box 191
  Canon City, CO 81212
  (303) 275-1661

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